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(54) PRESSURE TRANSDUCER

(71) We, EMI LIMITED, a British company of Blyth Road, Hayes, Middlesex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to pressure transducers.

Plastics polymers are known which can be caused to exhibit a piezo electric effect by suitable treatments. Bodies of such polymers can be provided with suitable surface electrodes whereby voltage generated on stressing the body can be conducted to a suitable measuring instrument thus forming a transducer. However the required conductive connections to an electrical source can create a hazard in certain uses e.g. in medicine, if the stressed body breaks to expose the electrodes.

It is an object of the invention to provide an improved transducer.

According to one aspect of the invention there is provided a transducer including a body of a piezo-electric plastics polymer deformable by pressure to generate and sustain a static surface voltage on the body and means to measure by induction the static surface voltage.

The measuring means may be a "field-mill". The transducer may be a fluid-pressure measuring transducer.

Embodiments of the invention will now be described with reference to the drawings accompanying the Provisional Specification in which:

Figure 1 shows a transducer and

Figure 2 shows such a transducer in an operative arrangement.

Figure 1 shows a transducer including a body of a piezo-electric plastics polymer in the form of a piece of film 10 of polyvinylidene fluoride or polyvinyl-chloride prepared in a suitable manner, e.g. by placing the heated film in an electric field and allowing the film to cool in the field, to become piezo-electric.

The prepared film 10 is stretched across the mouth of a vessel 11 to close the vessel and form a pressure cell generally indicated at 1 in which fluid pressure applied through an inlet port 12 can be exerted on the film 10. A fluid-pressure conduit 13 may be sealingly connected to port 12 by gland 14. The film 10 is held on vessel 11 by a clamping ring 15. Preferably the pressure cell 1 is a unit of the transducer which is engageable with a sensing unit 2, being held by a suitable clip, or the like, not shown.

Sensing unit 2 includes a case 21 housing a rotatable "field-mill" element 22 and a drive means 23 for element 22. The case 21 receives the cell 1 and has a ledge 24 to locate the cell 1 with respect to element 22. An electrical conductor terminal 25 is insulatingly supported near to the element 22 on the side remote from the film 10. A conductor 26 extends, insulated from case 21, for connection to an external measuring instrument such as a voltmeter V. Clearly conductor 26 may make plug-and-socket connection at the surface of case 21. Drive means 23 is preferably electrically operated and energised from a source 28 via connector 27 in suitable manner. One or more vents 29 are provided in case 21.

Element 22, which forms the "field mill" by which the potential on the surface of film 10 is detected, may be a multi-bladed element as shown in the drawing in which case drive means 23 is arranged to rotate the element to "chop" the space between terminal 25 and film 10 with the element blades. In another embodiment element 22 may be a blade reciprocated in a direction parallel to the plane of Figure 1 to so-chop the space.

As the piezo-electric properties of many materials are temperature dependent care in use at different temperatures may be needed.

In operation a fluid pressure exerted in cell 1 to a pressure different from that in vented case 21 will flex film 10. Film 10 when flexed develops a surface charge from the strain-produced static voltage. The charge is related to the strain in a reproducible manner and the relationship is

stable. The voltage does not leak quickly as the plastics film 10 is a good insulator. The field mill element 22, by its "chopping" of the space between the charge on film 10 and the terminal 25, causes the intermittent induction of a potential on terminal 25 which potential, connected to earth via a high series resistance instrument (R circa 10^3 ohms) V, is detectable as an alternating voltage due to the decay of the induced voltage through the instrument impedance between each induction. R must be at least 10^6 ohms.

As the diaphragm formed by the plastics film is thin, e.g. 0.05mm to 0.25mm, only relatively low pressure differences will be supported without risk of rupturing the film. However if required the film could be supported on another material, e.g. metal foil connected to earth, to resist and measure higher pressures. Even if the film does rupture the high series resistance of the instrument V will prevent terminal 25 attaining a voltage sufficient to cause harm to an individual to whom the transducer has been applied. In particular in medical applications fluid pressure conduit 13 may extend as an intra-venous or similar catheter to measure the pressure in a vein or like vessel of the body. In such an application with transducers having electrodes necessarily energised from relatively low-impedance sources a few volts or tens of volts can be applied to the body via the blood stream when electrode-bearing transducers rupture, with potentially dangerous or fatal result. With the transducers described above no such risk arises, as explained, because of the high impedance, even if electrodes are used.

In an arrangement for medical use the pressure cell 1 is produced as a sterile disposable element for insertion into the case of the sensing unit 2 and connection to a catheter 131. The cell 1 may be some 1cm × 0.5cm × 0.5cm.

The unit 2 is connected via conductors 26 and 27, described above, to a display unit DISP which also energises the drive-means 23. With this arrangement the relatively cheap sterile element 1 protects the patient from infection while the relatively expensive unit 2 need not be sterilised. Unit DISP may display the pressure directly or indicate the voltage generated so that the pressure can be calculated. The display of unit DISP may be a chart recorder or meter or other suitable form.

WHAT WE CLAIM IS:—

1. A transducer including a body of a piezo-electric plastics polymer deformable by pressure to generate and sustain a static surface voltage on the body and means to measure by induction the static surface voltage.

2. A transducer according to claim 1 in which the body of polymer is a plastics film placed as a diaphragm on a vessel to form a fluid-pressure chamber, into which, in operation, fluid pressure change is introduced to deform the diaphragm from a rest position.

3. A transducer according to Claim 2 in which the vessel and diaphragm together constitute a cell, separable from a case which houses said induction measuring means, whereby a replacement cell can be introduced into the housing.

4. A transducer according to any one of Claims 1 to 3 in which fluid pressure is, in operation, applied to the plastics body via a medical catheter.

5. A transducer according to claim 4, when dependent on claim 3, wherein said cell comprises a sterile package cell for introduction into the housing.

6. A transducer according to claim 5 in which the sterile package includes a catheter.

7. A transducer according to any one of the preceding claims in which the body of polymer is a plastics film supported on a layer of material to withstand pressure in excess of that safe for the unsupported layer.

8. A transducer according to any one of the preceding claims in which the induction measuring means is a field-mill.

9. A transducer according to any one of the preceding claims in which the induction measuring means is energised via a resistance in excess of $10^6\Omega$, whereby the risk of electric shock from the transducer is restricted.

10. A fluid pressure transducer for measuring intra-venous or like fluid pressure, the transducer including, in combination, a housing, containing means to measure static surface voltage by induction, and a fluid pressure cell, having a piezo-electric plastics polymer diaphragm, the housing being adapted to receive the cell with said diaphragm disposed adjacent said induction measurement means to permit voltage on said diaphragm, resulting from said fluid pressure applied thereto over a catheter connected to said cell, to be measured by said induction measurement means; means being provided to display the measured voltage, or a quantity derived therefrom, as an induction of said fluid pressure.

11. A fluid pressure transducer substantially as herein described with reference to the drawings accompanying the Provisional Specification.

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1585461 PROVISIONAL SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

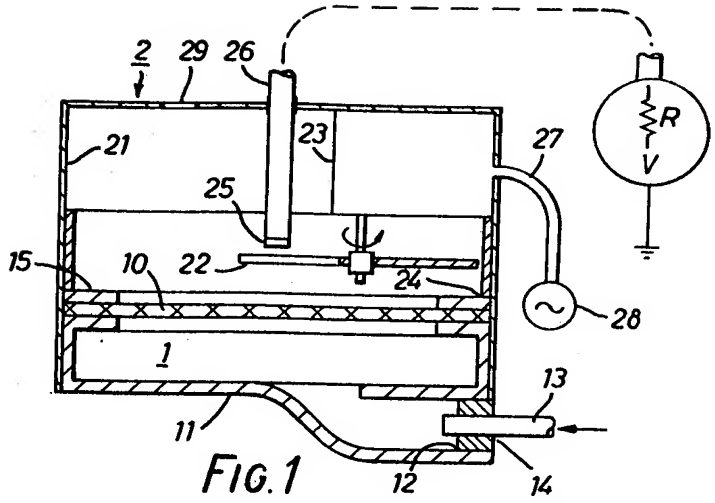

FIG. 1

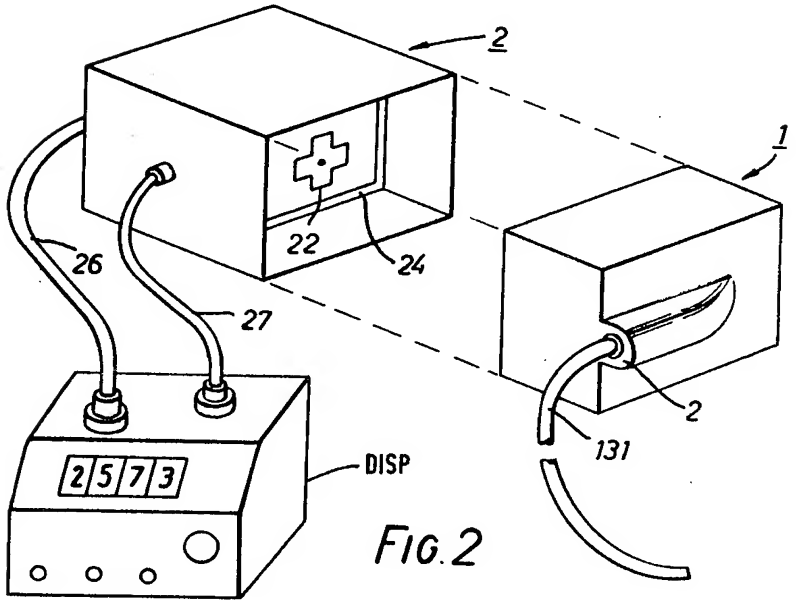

FIG. 2